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Innovative Pesticide Kit Model for Vegetable Farm Safety Surveillance Program

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Abstract

To develop 4-groups innovative pesticide test kit and vegetable farm safety surveillance program, the quasai study was performed in intervention klongtabak and control ta-ngoy village groups, Nakhonratchasima province. 62 Chinese kale samples were screened for pesticide residues using innovative test kit and confirmed by GLC/HPLC. Percent acetyl cholinesterase inhibition was measured in vegetable samples, containing anti-cholinesterase pesticide residues, using spectrophotometer. Pre-intervention analysis, two detected chlorpyrifos (>MRL) in control group, two detected cypermethrin (<MRL) and one detected <MRLs methomyl, carbofuran and carbofuran-3-OH in study group. No pesticides were detected in both groups at post-intervention. Self-test was trained to agriculturists, 92% accuracy competence results was acceptable at post-laboratory kit test training. Small farm land pesticide safety manual was used to educate agriculturists and %enzyme inhibition measurement at post-intervention period, compared with pre-intervention period was decreased 51.9% at p-value <0.011, reveal that intervention program affect reduction of pesticide inhibition at 0.05% significance level.

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Keywords: Innovative pesticide kit model, vegetable farm, safety, surveillance program

1. Introduction

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Recognizing that agricultural farming, the most common sector of Thailand represented 65% of labor force in 2006 (1). Some contaminated pesticides in the environment and accumulated in the food chain, posing hazards to human health, maturely organophosphate, carbamate, pyrethroid and organochlorine (2). The first three groups were popularly used for farming, while the organochlorine was banned in many countries (3), it was still being used in Thailand (4). Despite prohibition process and public announcements regarding bans, the weak enforcement in Thailand, resulted use of prohibited pesticides, as documented continued use of endosulfan, methamidofos, parathion-methyl, and monocrotofos (5, 6, 7). Many farmers believed that pesticide application was necessary and continued use of large amount of pesticides was likely unless a campaign was conducted that educated farmers, changed pesticide attitude and proper pesticide use (8). Pesticide residues were highly detected in marketed Chinese kale vegetable by MOPH, Thailand, (9). Detected unsafe pesticide residues in 22 samples, 5.6% of 396 vegetable samples**,** marketed in Suranakorn central market, Nakhonratchasima province, 9 out of those 22 (40.9%) were tested pesticide unsafe in Chinese kale samples (10). The contamination could not be treated in isolation from the environment which food was produced, simple test method must be evaluated, where results can help improve pesticide application strategies and develop remediation (11). Validated test kit of Department of Medical Sciences, granted petty patent from Thailand Intellectual Property Department, using to screen 4 pesticide groups in vegetable farm samples (12). Pesticide monitoring should be emphasized for food safety. Transfer of innovative kit technology to strengthen agriculturists should be focused for the safety monitoring of pesticide contamination to guarantee vegetable produce safety. Some pesticides particularly organophosphate and carbamate had ability of inhibiting the acetyl cholinesterase enzyme and % enzyme inhibition assay can be measured in vegetable by spectrophotometer to evaluate difference of variables after intervention study. Small farm land pesticide safety education should also be trained to agriculturists for safe farm produce with less chemical use and proper cultivation practice.

2. Aim of the study

The study was aimed at evaluating the effectiveness of innovative pesticide kit model for farm safety surveillance program by measuring association of pesticide residues in vegetable produce by agriculturists in Klongtabak village, Nakhonratchasima province before and after intervention, and transferring technology of self-test LAB in study farm community, obtained by training and testing their laboratory competency.

3. Materials and Methods

The quasai study was conducted during March 2012 to October 2013, the protocol was reviewed and approved by the Institutional Review Board of Ethical Committee of Chulalongkorn University, Thailand.

3.1. Innovative pesticide test kit, spectrophotometer and GLC/HPLC use to assay pesticide residues

To intensify safe agricultural production with less chemical use and awareness of good and safety practice, using integrated model of knowledge and innovative pesticide kit, was needed to reduce toxic contamination. Pesticide residues in farm produce was difficult to be measured by reference laboratory that is very expensive and time consuming. (13). Department of Medical Sciences' researchers developed test kit 4 groups of pesticide residues in vegetable, fruit and cereal that was validated to have high specificity, accuracy and sensitivity (14). Used Spectrophotometer for % acetyl cholinesterase inhibition assay, that was inhibited by organophosphate and carbamate pesticides, more than limit of detection in samples by test kit and above tolerance enzyme inhibition level by the colorimetric assay (15), were quantitatively determined of 4 groups

pesticide residues by gas liquid chromatography and high performance liquid chromatography (16,17).

3.2. Education tools: Small farm land pesticide manual, test kits, procedures, electronic and hard copies

Small farmland pesticide manual for farm safety surveillance (18), using the test kit and knowledge, was reviewed and edited by authors and klongtabak vegetable farm safety network to contain important educated topics that were pesticide handlings and safe pesticide use to man and the environment, good agricultural practice, prevention and control of important pests, integrated pest management, pesticides and their grouping by mode of actions and toxicity classes, chemical safety monitoring and reduction by community if found unsafe pesticide residues in their produce. Educational tools and medias, electronic and hard copies; you tube, DVD, books, printed articles, leaflets, procedures, agricultural and health sciences knowledge were provided for agriculturists.

4. Intervention of innovative pesticide kit model for farm safety surveillance program

The quasai study was performed in study group of klongtabak village, ladbuakao subdistrict in Sekhiew district and control group of ta-ngoy village, Chanthuek subdistrict, Pakchong district in Nakhonratchasima province. Chinese kale vegetable was purposively studied from cultivated farms and measured for pesticide residues before and after intervention. 62 Chinese kale samples were collected, 31 each, from the study and control farms, 1 sample from each vegetable plantation. About 80% of household volunteers (40 farmers) in study group, were knowledge-educated and laboratory technology transferred of innovative test kits. The test kit was used to screen 4 groups pesticide. % cholinesterase inhibition assay using spectrophotometer was measured in all samples. Unsafe samples or suspected to be unsafe, were sent to test 4 groups pesticide residues at central laboratory using gas liquid and high performance liquid chromatography. In addition to laboratory test by researchers, technology transfer of self test laboratory in study farms obtained by training agriculturists for safety monitoring by community. Regarding their laboratory competency, Proficiency test samples were prepared and analyzed by researchers and also tested by farmers for inter-laboratory comparison of innovative test kit. Small farm land pesticide safety was educated to agriculturists for safe farm production with less toxic chemical use and awareness of proper cultivation practice and safety for consumers.

5. Evaluating effectiveness of innovative pesticide kit model for farm safety surveillance program

Transfer technology of self-test laboratory in Klongtabak farms, obtained by training agriculturists and volunteers for safety monitoring by the community. For competency test, inter-laboratory comparison of innovative test kit by farm volunteers with competent analysts from reference laboratory, Department of Medical Sciences, was performed. Collected kale samples were tested and 92% accuracy was found at post laboratory training, revealed satisfactory acceptable results compared to 77% accuracy at first laboratory training.. 62 collected Chinese kale samples, 31 samples from each group. All kale samples were analyzed by spectrophotometer for % cholinesterase inhibition assay that organophosphate and carbamate pesticides inhibited the enzyme. Detected or suspected unsafe, were determined quantitatively of 4 groups pesticide residues (Codex's MRL) using GLC and HPLC by central laboratory; Before intervention , two detected samples of chlorpyrifos (>MRL) in control, two detected samples of cypermethrin (<MRL) and 1 detected <MRLs of methomyl, carbofuran and Carbofuran-3-OH in study group but none were detected from both groups at post intervention period (see table 1). Results of % cholinesterase enzyme inhibition in Chinese kale, analyzed by researchers using spectrophotometer showed compared percentage difference of enzyme inhibition between before and after intervention period. The within intervention group, results of decreased

enzyme inhibition at post intervention, compared with pre-intervention was 51.9%, the % difference had *p*-value<0.011 using dependent t- test, revealed that intervention program affect pesticide residue reduction of enzyme inhibition at the 0.05% significance level (see table 2, 3). To compare difference within control group, results of increased enzyme inhibition at post intervention, compared with pre intervention was 38.9%, the % difference had *p*-value < 0.001 by using dependent t-test (see table 2, 4).

Table 1. Test results in collected vegetable from control and intervention farms by researchers from reference laboratories.

Sample frequency	Screen 4 groups by test kit	Special Instrumental Analysis	International Standards
Control (Pre-Test)	Pre intervention period test	GLC/HPLC measurements	CODEX's MRLs
29 samples	Not Detected	-	-
2 samples	Pesticide Detected	Chlorpyrifos 3-3.5 mg/kg	1 mg/kg (Chinese cabbage)
Control (Post-Test)	Post intervention period test	GLC/HPLC measurements	
31 samples	Not Detected	-	
Intervention (Pre-Test)	Pre intervention period test	GLC/HPLC measurements	
28 samples	Not Detected	-	
2 samples	Pesticide Detected	Cypermethrin 0.1-0.2 mg/kg	0.7 mg/kg (Leafy vegetable)
[+]1 sample	Not Detected by test kit but-	Methomyl 0.16 mg/kg	5 mg/kg (Cabbage head)
[+]Suspected unsafe	-high % Enzyme Inhibition,	Carbofuran 0.14 mg/kg	1 mg/kg (Common bean)
	sent for GLC/HPLC analysis	Carbofuran-3-OH 0.13 mg/kg	-
Intervention (Post-Test)	Post intervention period test	GLC/HPLC measurements	
31 samples	Not Detected	-	

Table 2. Vegetable measurement of % Enzyme Inhibition by researchers using spectrophotometer in samples from both groups

%Enzyme Inhibition (%I)	Control (Pre Test) Frequency	Control (Post Test) Frequency	Intervention (Pre Test) Frequency	Intervention (Post Test) Frequency	Mean Difference (%I)	Difference % I (%Increase / %Decrease Enzyme Inhibition)
0-10	24	20	22	22		
>10-20	7	8	4	8		
>20-30	0	1	3	1		
>30-40	0	0	2	0		
Total	31	31	31	31		
Mean (% I)	4.99	6.93	8.08	3.89		
Mean Increase (%I)		6.93-4.99			1.94	1.94/4.99 x100 = 38.9%
Mean Decrease (%I)				3.89-8.08	-4.19	4.19/8.08 x100 = 51.9%

Table 3. Comparing the difference within intervention group by using dependent t-test

Intervention measurement	Pre intervention (N =31)		Post intervention (N =31)		*p*-value
Intervention study group	Mean	SD.	Mean	SD.	0.011*
% Enzyme Inhibition	8.08	10.70	3.89	6.39	*significant at *p*-value < 0.01

Table 4. Comparing the difference within control group by using dependent t-test

Intervention measurement	Pre intervention (N =31)		Post intervention (N =31)		*p*-value
Control group	Mean	SD.	Mean	SD.	0.001**
% Enzyme Inhibition	4.99	6.29	6.93	6.89	**significant at *p*-value < 0.001

6. Discussion, conclusion and recommendations

Innovative pesticide kit model for farm safety surveillance was developed, including innovatively invented pesticide test kit to test residues in farm and co-operatively worked with agriculturists in a pilot study farm community. Chinese kale was purposively selected as risky pesticide contaminated vegetable for monitoring. If tested pesticide residues are above maximum residue level (MRL), farmers should label unsafe samples. The unsafe results should be communicated to stake holders for discussion and participation to solve problem using innovative pesticide kit model of farm knowledge and technology for reducing contaminants in farm produce. Regarding few samples, detected pesticide residues more than Codex's MRLs at the pre intervention period and no detected samples in post intervention and also low mean % enzyme inhibition (see table 1-4), all the enzyme inhibition findings showed low pesticide residues, below the tolerance level of toxicity by the chemical analysis (19). Chinese kale, collected cultivation period was 45-55 days for sale and was proper period for sample collection and testing pesticides. Farmers frequently use anti fungal, new formulated pesticide groups and bio-pesticide, these are likely non-cholinesterase enzyme inhibition pesticides, during harvesting period. The limitation, innovative test kit was tested for 4 groups: organophosphate, carbamate, pyrethroid and organochlorine. At pre intervention period, the pesticides were still being used in farms but at post intervention, none of the 4 groups were detected in both groups (see table 1). Each of organophosphate and carbamate was used at harvesting period by 5 % of users in study group and several kinds of the new pesticides are widely used at 10-40 days and harvesting period in intervention and control farms (20). The public and government stake holders shall know toxic information of the new pesticides and probable mutagenic and teratogenic effects. New pesticide laboratory field tests are more difficult and need further development. Transfer technology of self- test laboratory in intervention farms obtained by training agriculturists, shall be beneficial for self-economy to add agricultural value for ASEAN countries and follow self dependence and sustained economy policy of the royal Thai government. To test farmers' competency, inter-laboratory test comparison in the proficiency test samples using innovative test kit by farm volunteers with competent analysts of Department of Medical Sciences. Test progress result of 92% accuracy (8% false test), was satisfactory acceptable and documented at post laboratory training. The small farm land pesticide safety of good agricultural practice was educated to agriculturists for safe farm production. Three main intervention tools; innovative pesticide kits, self-test transfer technology and small farm land pesticide education were included in the innovative pesticide kit model for farm safety surveillance program and aimed at evaluating the study effectiveness by comparing association of pesticide residues in kale produce before and after the intervention. Study group results, show decreased % enzyme inhibition at post intervention period, compared with pre-intervention of 51.9% at *p*-value < 0.011, reveal that the intervention program affect reduction of pesticide inhibition at 0.05% significance level. The program of this pilot model could be used for other communities and self economy strategy that can bring benefits globally.

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